Chemistry 129.01 - General Chemistry Workshop - Spring 2017

Week #10

Monday, April 10. Acid-Base Equilibria
Assigned reading: Section 4.2, 14.1-14.3

Acid-base chemistry is a fundamental reaction type. This chemistry is extremely well understood and serves as an excellent basis to understanding other types of reactive chemistry. Acids and bases were first recognized by the properties of their aqueous solutions. Sections 4.2 and 14.1 describe the fundamentals of acid-base chemistry, defining both an acid and a base.

Water ionizes to a small degree forming H_3O^+ and OH^- (the autoionization of water). When acids and bases dissolve in water the concentrations of these ions change. We'll learn how to write chemical equations of the ionization of acids and bases in water. For acids, I personally prefer the use H_3O^+ instead of just H+. We will discuss why in class, but basically it boils down to this. You NEVER see a H^+ on its own in solution phase, it is always stuck to something else (usually water), and I think that only drawing it as H^+ is very misleading. Get in the practice of writing H_3O^+ instead of H^+.

The concentrations of H_3O^+ and OH^- can be expressed as pH or pOH. These scales convert concentrations of H_3O^+ or OH^-, respectively, (often very small numbers) to nicer numbers between 0 and 14. Much easier to remember and use numbers like that. Pay particular attention to make sure you know what side of the scale is basic and which side is acidic.

We'll spend quite a bit of time working on acid-base equilibrium problems to determine the pH of solutions of strong or weak acids and bases. These problems are pretty much identical to the ones we worked on last week. As soon you make the connection that all equilibrium problems are solved the same way regardless of the type of reaction, problem solving will become much easier.

1. Define the following concepts and symbols:

   weak electrolyte

   pH scale

   Acidic solution

2. What do we call the reaction between an acid with a base? Give an example.

Notes:

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Friday, April 14. Acid-Base Equilibria

Assigned reading: Sections 14.3 – 14.4

At the end of section 14.3 the concept of acid strength depends on the structure of the acid is introduced. This is a topic that we should do well with. We'll be looking at the periodic trends, which this class knows extremely well. Think about going across a row on the periodic table. Based on electronegativities, what will be the strongest acid out of these three compounds: NH_3, H_2O, HF? We will also look for and discuss trends for oxyacids and halogenated acetic acids strength.

Section 14.4 discusses salts and how to determine whether a salt is acidic, basic or neutral. This could be a little tricky sometimes. The acid-base properties of salts will depend on the identity of their respective cations and anions. If the ions react with water will result in a pH change. We'll discuss which ions undergo hydrolysis and which do not.

1. Give an example of one of the following types of acids and draw it's Lewis structure:

   Binary acid

   Oxyacid

   Halogenated Acetic Acid

2. Give the chemical formula of:

   The conjugate acid of NH_3:

   The conjugate base of HNO_2:

Notes:

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Problem Set #10

Due Monday, April 17 (at the beginning of class). Late homework will not be accepted.

1. Explain how ammonia can be classified as both an Arrhenius and a Brønsted-Lowry base.

2. Draw the Lewis structures of all the reactant and products in the following reactions, designate the Brønsted-Lowry acid and base on the left side and also designate the conjugate acid and base on the right side of the equation:

   a. $NH_4^+{}_{(aq)} + CN^-{}_{(aq)} \Leftrightarrow HCN_{(aq)} + NH_{3\,(aq)}$
   b. $HSO_4^-{}_{(aq)} + HCO_3^-{}_{(aq)} \Leftrightarrow SO_4^{2-}{}_{(aq)} + H_2CO_{3\,(aq)}$
   c. $(CH_3)_3N_{(aq)} + H_2O_{(l)} \Leftrightarrow (CH_3)_3NH^+{}_{(aq)} + OH^-{}_{(aq)}$
   d. $HBrO_{(aq)} + H_2O_{(l)} \Leftrightarrow H_3O^+{}_{(aq)} + BrO^-{}_{(aq)}$

3. Complete the following table (show your work):

pH	**pOH**	**[H$^+$]**	**[OH$^-$]**	**Acidic or Basic**
5.06				
	3.52			
		2.4×10^{-3}M		
			7.6×10^{-4}M	

4. Calculate the pH of the following solutions: (a) 0.0167M HNO_3 (b) 0.0105M $Ca(OH)_2$.

5. A 0.100M solution of bromoacetic acid ($BrCH_2COOH$) is 13.2% ionized. Calculate [H^+], [$BrCH_2COO^-$], [$BrCH_2COOH$] and K_a for bromoacetic acid.

6. The acid-dissociation constant of hypochlorous acid (HClO) is $3.0\text{X}10^{-8}$. Calculate [H_3O^+], [ClO^-], [HClO] and the pH of the solution at equilibrium if the initial concentration of HClO is 0.0090M.

7. Calculate [OH^-] in a 0.550M solution of hypobromite ion (BrO^-, K_b=4.0×10^{-6}). What is the pH of this solution?

8. Hypochlorous acid, HClO, has a pKa of 7.53 and chlorous acid, $HClO_2$, has a pKa of 1.96. Which is the stronger acid, HClO or $HClO_2$? Which is the stronger base, hypochlorite (ClO^-) or chlorite (ClO_2^-)? Why?

9. Based on their molecular structure, pick the stronger acid from each of the following pairs. Explain your reasoning. Draw their Lewis structures.

   (a) HCl or HF
   (b) $HClO_2$ or $HClO_4$
   (c) $HClO$ or $HBrO$
   (d) CCl_3COOH or CH_3COOH

10. Classify the following salts as acidic, basic or neutral.
    (a) $FeCl_3$
    (b) NaF
    (c) KCl
    (d) $(CH_3)_3NHCl$
    (e) $NH_4C_2H_3O_2$